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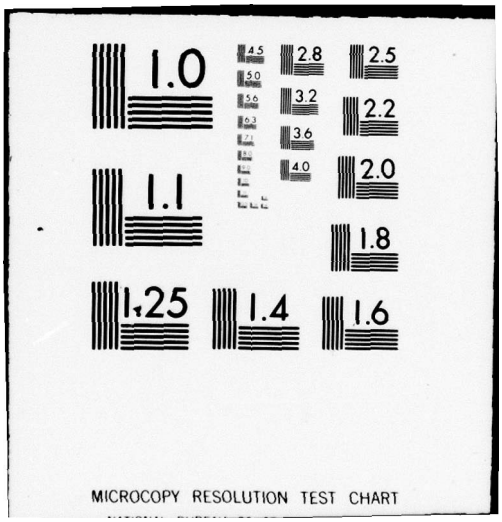
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This bibliography is a fairly complete alphabetical listing of papers from the engineering literature on nonparametric detection theory and applications, covering approximately the twenty-year period 1959-1979.

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A BIBLIOGRAPHY ON NONPARAMETRIC DETECTION

By

Saleem A. Kassam

Abstract

This bibliography is a fairly complete alphabetical listing of papers from the engineering literature on nonparametric detection theory and applications, covering approximately the twenty-year period 1959-1979.

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INTRODUCTION

The field of nonparametric detection has attracted increasing attention over the last several years. Nonparametric detection procedures have found applications in diverse areas such as radar and sonar, pattern recognition, communication theory, fault detection, and bio-medical signal processing. Much of the available literature on this topic is to be found as papers published in a variety of technical journals and proceedings of conferences. The following alphabetically ordered list was compiled in an attempt to collect in one place most of the works on nonparametric detection which have appeared in the last twenty year period. The list does not include technical reports of limited availability, and is also confined to the engineering literature, so that the sizeable body of statistical literature has been omitted. However, it should be possible to obtain much of this literature indirectly through the entries indexed. Although it is believed that this bibliography is fairly complete, some inadvertent omissions are inevitable, given the variety of the sources, and the inherent difficulty of compiling such a bibliography.

Nonparametric detectors are based on statistical hypothesis testing principles for situations where parametric statistical models cannot be specified for the observation under the

null hypothesis. A nonparametric formulation for a statistical problem generally defines a class of allowable distribution functions which cannot be completely described by, or indexed by, a finite number of parameters. An example of a nonparametric formulation of an hypothesis about a random variable X is the hypothesis that X has an absolutely continuous distribution function F(x) satisfying $F(-x) = 1 - F(x)$, $-\infty < x < \infty$.

The term "nonparametric" applied to detectors has not always been used with a uniform meaning by authors in this field. Most authors use the term "nonparametric procedure" to mean a procedure for statistical inference with some performance characteristic which is invariant over large classes of underlying probability distributions subject only to mild conditions, that is, over nonparametric classes for the distributions. The usual performance characteristic in nonparametric testing or detection is the type I error probability or false-alarm rate. In some applications involving the use of training or reference samples, the condition of invariance of this error characteristic is replaced by the requirement of invariance at a design value of the probability that this error measure remains bounded by a desired level.

In most of the engineering literature no distinction is drawn between the terms "nonparametric" and "distribution-free" as applied to inference procedures. In the statistical literature a distribution-free procedure is one based on a

statistic, computed from the observation, whose distribution is independent of the precise form of the distribution function of the observation. Thus we may say that (in our terminology) a distribution-free test has a test statistic whose distribution function is independent of the observation distribution function specified by some nonparametric hypothesis. In this case it is usually permissible to treat the terms "nonparametric" and "distribution-free" as being synonyms. Where a distinction is made in the statistical literature, a nonparametric test is one designed for an hypothesis which is not a statement about the numerical values of parameters in a distribution function. This distinction is not generally made in engineering applications.

In some engineering work the term "nonparametric" or "distribution-free" is used to refer to any scheme derived without utilizing any specific parametric assumptions on the statistical characterizations for the random variables involved, even though there is no performance invariance. Such work has not been included here. The description "CFAR" (constant false-alarm rate) is often used in radar and sonar applications. Since a procedure may be "CFAR" for a parametric class of probability distributions but not for larger classes, a "CFAR" procedure may not necessarily be a "nonparametric" procedure. On the other hand, most nonparametric detectors and all distribution-free detectors may be described as being CFAR procedures. It should also be noted that sometimes the term "nonparametric" is used for a procedure which

may more accurately be labelled as being "asymptotically nonparametric", with nonparametric performance in the limit when sample sizes tend to infinity. This is usually true for adaptive schemes.

Nonparametric statistical theory offers one approach for designing inference procedures in situations where parametric models cannot be assumed. Robust procedures may also be applicable in situations like these, and have, indeed, received much attention in the engineering literature. In robust hypothesis testing or detection not only the false alarm probability but also the power of the test is considered in defining a performance criterion. The classes of allowable observation distributions are again nonparametric, and a robust test will maintain reasonable performance (false-alarm probability below an upper bound, and acceptable power characteristics) over these nonparametric classes. Typically, the allowable distribution classes have enough structure to allow robust tests to be obtained which maximize worst-case detection power, or some performance criterion based on power considerations. One often-used model for allowable distribution functions in statistical formulations having non-trivial solutions for robust tests is the mixture or contaminated nominal distribution model. However, other models are also possible. Since power considerations are not explicitly used in defining the nonparametric property of a test, such a test may have low power for some alternatives when compared to a robust test for the same statistical

formulation. On the other hand, it may well be that the robust test will have power performance which may be poor compared to the nonparametric test for a specific alternative of interest. Clearly, the use of a robust test will be advantageous in situations where power considerations for nonparametric alternative hypotheses are important, and where the underlying nonparametric classes of distribution functions are narrower, by virtue of specific information, such as about nominal distributions, being available. In addition to robust detection, robust methods of signal and parameter estimation have also been of much interest in engineering. Ideas of such robust statistical procedures are closely connected with the concepts of universal and robust source coding and quantization.

This bibliography on nonparametric detection includes some references which contain material closely related to nonparametric detection theory and practice. Thus, for example, some references having to do with aspects of detector performance comparisions are included. It is hoped that a similar bibliography on robust procedures can be compiled in the future.

Preceding the alphabetical list below is a list of sources, and corresponding abbreviations, which were used in compiling the bibliography. This should be informative in showing the variety of sources in which developments and applications of nonparametric detection theory have been reported.

LIST OF SOURCES AND ABBREVIATIONS USED IN THE BIBLIOGRAPHY:

IRE/IEEE Transactions	Trans.
Automatic Control	AC
Aerospace and Electronic Systems	AES
Audio, Speech and Signal Processing	ASSP
Computers	C
Communications	COM
Information Theory	IT
Reliability	R
Systems, Man and Cybernetics (formerly Systems Science and Cybernetics)	SMC (SSC)
Sonics and Ultrasonics	SU

IRE/IEEE Proceedings	PROC

IRE/IEEE Conferences, Conventions and Symposia	
Canadian Communications and Power Conference	CCPC
Decision and Control Conference	DCC
Electronics and Aerospace Systems Convention	EASCON
International Conference on Acoustics, Speech and Signal Processing	ICASSP
International Conference on Communications	ICC
International Convention	ICONV

International Radar Conference	IRC
International Symposium on Information Theory	ISIT
National Aerospace Electronics Convention	NAECON
National Communications Symposium	NCS
National Electronics Conference	NEC
National Telecommunication Conference	NTC
Pattern Recognition and Image Processing Conference	PRIPC
Reliability and Maintainability Symposium	RMS
Symposium on Adaptive Processes	SAP
Southwestern IEEE Conference	SWIEEECO
Western Electronic Show and Convention	WESCON

Other Publications

Allerton Conference on Communications, Control and Computing (formerly Allerton Conference on Circuit and System Theory)	Aller. Conf. Comm., Contr. &Comp. (Aller. Conf. Circ. & Syst. Theory)
Asilomar Conference on Circuits and Systems	Asilomar Conf. Circ.& Syst.
Automation and Remote Control; Translation of Avtomatika i Telemekhanika (Consultants Bureau)	Auto. Rem. Control
Computers and Electrical Engineering	Comp. Elec. Eng.

Conference on Information Sciences and Systems (Princeton or John Hopkins)	Conf. Inf. Sci.& Syst.
Engineering Cybernetics; Translation of Tekhnicheskaya Kibernetika (Scripta)	Eng. Cyb.
Hawaii International Conference on Systems Science	Hawaii Int'l Conf.on Syst. Sci.
Institution of Electrical Engineers Conference Publication	IEE Conf. Publ.
Information and Control	Inf. and Control
Information Sciences	Inform. Sci
International Telemetering Conference	ITC
Joint Conference on Mathematical and Computer Aids to Design(SIAM-ACM)	Joint Conf. Math.Comp. Aids to Des (SIAM-ACM)
Journal of the Acoustical Society of America	J.Acoust. Soc. Amer.
Journal of Cybernetics	J. Cyb.
Journal of the Franklin Institute	J. Franklin Inst.
M. J. Kelley Communications Conference (University of Missouri-Rolla)	M. J. Kelly Comm, Conf. (U. of Missouri-Rolla)
Midwest Symposium on Circuits and Systems	Midwest Symp Cir. & Syst.

Problems of Information Transmission; Translation of Problemy Peredachi Informatsii (Consultants Bureau)	Prob. Inf. Trans.
Radio Engineering and Electronic Physics; Translation of Radiotechnika i Electronika (Scripta)	Radio Eng. & El. Physics.
Radioelectronics and Communications Systems; Translation of Izvestiya VUZ. Radioelektronika (Allerton Press)	Radioelect. and Comm. Systems
Society for Industrial and Applied Mathematics: Journal on Applied Mathematics	SIAM J. App. Math.
Symposium on Computer Processing in Communications (Polytechnic Institute of Brooklyn)	Symp. Comp. Process. in Comm. (Poly. Inst. Brook.)
Symposium on Engineering Applications of Random Function Theory and Probability	Symp. Eng. App. Ran. Func. Theory & Prob.
Telecommunication and Radio Engineering; Translation of Elektrosvyaz i Radiotechnika (Scripta)	Telecomm. & Radio Eng.
Workshop on Communication Theory and Applications (Air Force Office of Scientific Research)	Workshop Comm. Theory & App. (AFOSR)

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